K. Watson (F.B.) 7 [illegible] 799 R
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COMPANION
TO THE
PLANISPHERICAL PLANETARIUM:

TO WHICH IS PREFIXED AN

ELEMENTARY INTRODUCTION

TO THE

SCIENCES
OF
ASTRONOMY and GEOGRAPHY:

In a conciſe and comprehenſive Treatiſe on the

SOLAR SYSTEM.

Forming a Preparatory Aſſiſtant to the

STUDY OF THE GLOBES.

Adapted to the ABILITIES and deſigned for the INSTRUCTION of

YOUTH.

Far as Creation's ample Range extends,
Far as each Ray of genial Light aſcends,
All are but Parts of one ſtupendous Whole,
Whoſe Body Nature is, and GOD the Soul. POPE.

LONDON:
PRINTED FOR THE AUTHOR,
AND SOLD BY
P. ELMSLY and D. BREMNER, No. 87, *Strand*; W. CLARKE, No. 38,
New Bond-Street; and J. WALLIS, No. 16, *Ludgate-Street.*
1797.

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MVSEVM
BRITAN
NICVM

TO

ADAM WALKER, Esq.

PHILOSOPHICAL LECTURER.

SIR,

THE courtly adulation with which Dedicators are ſometimes wont to addreſs their Patrons, affords me no precedent on this occaſion: for the opinion which the World has eſtabliſhed, of the juſtice of your acquired reputation, cannot be more radically confirmed by a flattering enumeration of your mental qualities. My deſire is unfeignedly to profeſs the grateful ſenſe I entertain of your condeſcenſion in patronizing this Publication, of which I thus beg permiſſion to offer you my fulleſt aſſurance; nor does my obligation reſt here; for among the many who have reaped the advantage of your inſtruction, I am proud to acknowledge myſelf one of thoſe who feel its impulſe.—I am,

SIR,

With the moſt ſincere reſpect,

Your truly obliged

and grateful Servant,

F. B. WATSON.

PREFACE.

By adding this Elementary Treatiſe to the number of editions already extant upon the Subjects of Aſtronomy and Geography, I cannot mean to depreciate any that have hitherto been publiſhed, or conſider them as inſufficient for the purpoſe for which this is deſigned; but as ocular obſervations impreſs much on the mind of Youth, and aſſiſt more in demonſtrating facts, than literal or verbal repreſentation, I conceived it would be an auxiliary to their ſtudy, by giving a delineated view of the relative poſitions of our Planet, in a more diſtinct and intelligible manner than can be effected by the Globe; to this purpoſe I truſt the

Planiſpherical Planetarium is competent: and as I could not introduce it to the Juvenile World without accompanying it with a Deſcription of its Parts, I deemed it not improper to preface that with an Elementary Introduction to the Sciences, to make it more ſuitable to thoſe who may not have hitherto entered upon thoſe ſtudies.

The Planetarium repreſents the principal and moſt intereſting parts of the Solar Syſtem, and diſplays to the eye that which it is neceſſary for the mind to conceive, in order to impreſs it with a due notion of the Earth's relative poſitions; thereby ſaving the Student ſome trouble, in aſſiſting, or rather effecting, the formation of this idea.

As a ſubſtitute for real motion, in deſcribing the revolution of the Earth, I have given it negatively, by repreſenting it in twelve of its various poſitions, and thoſe on the particular days of its entrance into the reſpective Signs of the Zodiac: this I conſider adequate to the purpoſe deſigned, ſince it requires but little conception to be ſenſible of the intermediate changes. As by repreſenting the body of a globe on a flat ſurface, and that in ſuch various poſitions, ſome ſeeming diſtortions will take place, I muſt crave the indulgence which other Planiſpherical Delineators have experienced.

ELEMENTARY INTRODUCTION

TO THE SCIENCES OF

ASTRONOMY AND GEOGRAPHY.

THE SUN.

THIS glorious Luminary, from whoſe ſource we derive the bleſſings of Light and Heat, and to whoſe genial power we chiefly owe the variation of Seaſon, and the maturity of all the productions of the Earth, is the great fountain of UNIVERSAL LIFE. It was with propriety called by the Ancients, the Heart of Heaven; for as the corporeal heart gives life and motion to the human frame, ſo does the Sun's vivific power operate through this our ſyſtem: when the heart ceaſes to palpitate, animal life is at an end; and if the Sun ſhould ceaſe to act, the whole of that ſyſtem would diſſolve into a Chaos.

The judgment of Aſtronomers in infant ages, has been greatly baffled in their reſearches into the nature and properties of this ſuppoſed igneous body; nor have our modern Philoſophers as yet definitively determined upon its inherent quality: it has long been conſidered, and it was the opinion of that great Philoſopher Sir Iſaac Newton, that it is an immenſe ſolid maſs of inexhauſtible fire, diffuſing its influence throughout all our Syſtem, and diſtributing its light and heat to the ſurrounding Planets, in proportion to their approximate ſituations.

But a Philoſophic Writer of the preſent day, has endeavoured to ſubvert this hitherto received idea, as an unphiloſophical hypotheſis, and aſſerts it to be a body poſſeſſing the ſame temperature as our Earth; he ſupports his opinion with very cloſe and ingenious arguments; but into the merits of this novel ſuppoſition, it is not eſſential here to inquire, leaving it a topic for argumentation among Philoſophers: it being in the preſent inſtance ſufficient to know, that it is indiſputably the body which diſpenſes animal and planetary life throughout the ſolar ſyſtem, and is the main ſpring in the mechanical ſtructure of that ſtupendouſly organized integral part of a more ſtupendous Univerſe.

Did this great Parent of our Syſtem poſſeſs a ſurface equally bright in all its parts, it could not, perhaps, have been aſcertained, whether it made any motion, or was a ſtationary glory in the Heavens; but by the aſſiſtance of teleſcopes, ſome dark ſpots (called the Maculæ Solares), have been diſcovered upon its diſk, or ſurface, by which its motion is diſcernible, for they are always firſt viſible on his eaſtern edge, and gradually advance towards the centre, and ſo paſs on till they reach the weſtern extremity, and then diſappear; and after having been concealed for the ſame ſpace of time that they remained viſible, again return to view as before on the eaſtern ſide, and, without variation, continue this rotation. The immerſions and emerſions of theſe ſpots inconteſtably evince the Sun's motion, and that motion tends to prove its globular form.

The Sun's motion, thus aſcertained, the next object with Aſtronomers was, to diſcover the time it employed in turning once upon its axis, which alſo, by obſervation, was found to be 25$\frac{1}{4}$ of our days; this was diſcovered by particularizing one of theſe ſpots, and reckoning the lapſe of time from its firſt appearance, to its return to the ſame poſition. This is the only material motion the Sun is diſcovered to make; for as he is in the centre of our ſyſtem, he cannot move round any of its Planets, though he is obſerved to make a ſmall revolution, moving round a point in like manner to the North Star. Yet the Via Solis, or Sun's Path, is a common expreſſion in Geography, by which it might be conceived that he has a regular orbit, in which he revolves round our Earth, and his diurnal appearance ſeems to ſanction the idea; for he ſeems regularly to riſe above the horizon in the morning, take his courſe over us, arrive at our meridian, and then gradually decline, and ſet in the evening, while, to all ſenſation, we are perfectly at reſt.

This is a wonderful deception practiſed on our ſenſes; nor can we be ſurpriſed at its powerful effect on juvenile minds, and therefore the difficulty of convincing them againſt what appears to them ocular demonſtration: indeed, we have many inſtances of deceptive motion, one of which will ſerve to prove, how liable we are to miſconception in this particular. We will ſuppoſe a perſon placed in a river upon his back, on a plank or piece of timber, ſo elevated above the ſurface of the water, that he can with eaſe perceive the objects on either ſide; ſuffer him in this manner to glide down the ſtream with a gentle tide, and he will be totally inſenſible of his own motion;

but the trees and objects on either ſhore, will ſo conſpicuouſly appear to him to move in an oppoſite direction to that in which he is really going, that, but for the endowment of reaſon, his ſenſes would incline him to believe that motion true. In like manner are we circumſtanced with reſpect to the Sun; we perceive his change of poſition, but we are viſually inſenſible of the motion which produces it: yet, it is unphiloſophical to ſuppoſe, that a body ſo vaſt as the Sun ſhould revolve round our Earth, ſo comparatively minute. Indeed, it is aſcertained beyond a doubt, that our Earth is the moving Orb.

From the immenſe diſtance of the Sun from us, his diſk does not appear to us larger than that of the Moon; yet his magnitude is wonderfully great, the diameter of his body being calculated at 890,000 Engliſh miles: how much do we loſe then by the compariſon, when we compare the ſize of our Earth, whoſe circumference even does not exceed 25,020 miles, to the vaſt dimenſions of the Sun. It is impoſſible to form an idea of the heat the Sun poſſeſſes (ſuppoſing it to be a globe of fire), when we, at the diſtance of above ninety millions of miles from him, are ſometimes overpowered by the intenſeneſs of his rays. As he is the mover of all the Planetary Orbs, I ſhall have occaſion to notice him further, as my purpoſe is to treat of them reſpectively: And order requires me to begin with thoſe two, whoſe orbits * lie between it and our Earth, for which reaſon they are called inferior, or more properly interior planets. Of theſe, that which comes firſt under our conſideration, is *Mercury*.

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* The orbit is the circle in which they move round the Sun.

* * *

MER-

MERCURY

Is the neareſt to the Sun, although at the computed diſtance of above thirty-ſix millions of miles; yet, from our relative diſtance, and the heat which we derive from the Sun, ſuch is the power it muſt ſeem to have upon this Planet, that, agreeably to an experiment made by Sir Iſaac Newton, the degree of heat it impreſſes thereon, is ſufficient to cauſe the ebullition of water; by which it would appear, that the calidity of Mercury renders it totally unfit for the habitation of creatures of our frame and conſtitution; and if bodies on its ſurface are not inflamed or ſet on fire, it muſt, on this ſuppoſition, be attributed to their poſſeſſion of a denſity almoſt inconceivable to us, and proportionate to the heat they are compelled to endure.

This Planet performs a revolution round the Sun, from Weſt to Eaſt, in 87 days, 23 hours, 15½ minutes, being rather leſs than three of our months, which compriſes its year *; ſo that this Planet makes more than four revolutions during the ſame period our Earth is effecting one, or has rather more than four years to our one; he runs his revolving courſe with the aſtoniſhing velocity of 110,680 miles per hour.

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* The year being the ſpace of time a Planet occupies in moving in its orbit round the Sun.

From his proximity to the great fountain of light, whoſe luſtre impedes obſervation, Aſtronomers have not hitherto been able to aſcertain what time it employs in making a rotation upon its axis, or even to diſcover whether it performs ſuch rotation or not, though this is a very natural preſumption, ſince it is a motion which all the other Planets are diſcovered to poſſeſs; for to ſuppoſe it had not this motion would be to acknowledge that one part of its ſurface is perpetually expoſed to the ſcorching rays of the ſolar beams, while the other enjoys but an indifferent twilight, or that thoſe inhabitants (if it be habitable), who dwell on that part of it expoſed to the Sun, have perpetual day, and thoſe in that part eloigned from it, perpetual night; an idea ſo inconſiſtent with our general knowledge of planetary movements, that it is but rational to ſuppoſe it to have a rotary motion, cauſing the agreeable ſucceſſion of day and night; but the time it employs in its performance, is a deſideratum left for future diſcovery.

When we conſider him as a ſtar, in which diminutive character from his extreme diſtance he appears to us, we view him emitting a very bright-white light, but from his vicinity to the Sun he is never to be ſeen at night, being then below the horizon; yet he is viſible a little before ſunriſe, if he is to the eaſtward, or a little after ſunſet, if he is to the weſtward of that luminary, and will always appear near the horizon, except during a ſolar eclipſe, when it is poſſible to ſee him even in the meridian while the light of the Sun is obſcured by the interpoſition of the Moon.

Mercury's greateſt elongation or apparent diſtance from the Sun in the heavens, is little more than 28 degrees, or about as far as the new Moon appears from the Sun on the ſecond day. Next to Mercury, from the centre of our ſyſtem, is the all-beauteous Planet *Venus*.

VENUS,

WHICH moving between Mercury and the Earth, is diſtant from the Sun above 68 millions of miles. Her magnitude is ſomething leſs than that of our Planet; but from her being at a greater diſtance from the Sun, and of a ſuperior bulk to the interior Planet, we are favoured with a longer and more diſtinct view of her than of Mercury: ſhe ſhines with a brilliancy, that makes her eminently conſpicuous among the numerous luminaries which adorn the ſky; ſhe emits a very bright-white light, exceeding that of all the other Planets, which is ſometimes ſo conſiderable that in a duſky place ſhe projects a very ſenſible ſhadow.

According to her poſition with regard to the Sun, ſhe is ſometimes ſeen in the morning before ſunriſe, and ſometimes in the evening after ſunſet; when ſhe is in that part of her orbit which is to the weſtward of the Sun, ſhe riſes before him in the morning, and is then called Phoſphorus, Lucifer, or the Morning Star; when ſhe is to the eaſtward of the Sun, ſhe ſets after him, or remains viſible in the heaven when he has declined below the horizon, and is then called Heſperus, Veſper, or the Evening

Star: her greateſt elongation or apparent diſtance from the Sun, is 48 degrees, wherefore ſhe can never be ſeen at midnight; but at her greateſt diſtance ſhe appears to us little more than half-way between the Sun when ſetting, and the Zenith, or that part of the heavens directly over our heads, and is only viſible for three or four hours in the morning or evening, according as ſhe is before or after, that is, Eaſt or Weſt of the Sun.

Her periodical courſe round the Sun, which compoſes her year, ſhe performs in 224 days, 17 hours, moving at the rate of nearly 81 thouſand miles per hour; which, though not equal to the velocity with which Mercury revolves, greatly ſurpaſſes that of our earth, making more than three courſes in the ſame ſpace of time that we are accompliſhing two.

As to the quantity of light and heat which Venus receives from the Sun, it is evident that it cannot be in ſo great a portion as that which Mercury enjoys; yet in a much greater degree than is reflected upon our Earth, that is, in proportion as her orbit is nearer to the Sun than ours.

The time ſhe employs in making a rotation on her axis, is, according to ſome aſtronomers, 23½

hours;

hours; according to others 24$\frac{1}{3}$ days; though there is a very ſingular difference between the ſpaces of theſe times, the error of the one is thus eaſily accounted for: Caſſini diſcovered that a ſpot on the ſurface of Venus, had advanced 15° in 24 hours, whence he concluded, that it had performed one entire rotation and 15° of another, as the ſpot appeared to him to advance ſenſibly in a quarter of an hour. But Bianchini, another celebrated aſtronomer, though he agreed with Caſſini that the ſpot had advanced 15° in 24 hours, would not allow that it had likewiſe effected an entire rotation in that ſpace of time, becauſe he could not diſcover that it had made any advance in three hours, and therefore concluded, that it advanced only at the rate of 15° in 24 hours, and that to complete its rotation would require 24$\frac{1}{3}$ days: the arguments on either ſide are very plauſible; but I believe moſt of the modern Aſtronomers have adopted the opinion of Caſſini. Mr. Ferguſon indeed is an exception.

There is a very great affinity between this Planet and our Earth; as it is diſcovered to poſſeſs the ſame motions revolutionary as well as rotary, and though not performed in the exact ſame ſpace of time, yet ſo in proportion to its bulk and orbit; the year of Venus conſiſts of 224 days, &c. whereas as our year conſiſts of 365 days, &c. but there is only half an hour difference in the length of the day and night (according to Caſſini), between our Planet and that of Venus, we making a rotation in 24 hours, and ſhe in 23½ hours; and in fact, though ſhe appears to us but as a lucid ſpangle in the heavens, we ſcientifically find her in bulk nearly equal to our Earth; her diameter being 7,699 miles, whereas the diameter of the Earth does not exceed 7,970, ſo that by compariſon ſhe is but little our inferior. She does not always ſhine with a full face, but when viewed through a teleſcope, has appearances ſimilar to thoſe of the Moon, being ſometimes full and ſometimes gibbous, or partly ſo, her illumined part being conſtantly turned towards the Sun, being like the other Planets an opake body, receiving all her light and heat from him; ſo that we do not ſee ſo much of her enlightened part when ſhe is between us and the Sun, as when ſhe is in that part of her orbit beyond the Sun.

To aſcertain whether this Planet is inhabited or not, exceeds the limits of man's inveſtigation; but it may very reaſonably be ſuppoſed to be ſo, ſince it is diſcovered to poſſeſs diurnal and annual motions like our Earth; but, though infinitely leſs heated than Mercury, yet its ſurface, like that of the other Planet, ſeems to be too intenſely ſo, for people of our conſtitution to dwell on; ſo that with regard to what kind of inhabitants it may be peopled (if any) our philoſophers have hitherto been diffident in hazarding a conjecture. Theſe are the general deſcriptive outlines of the two interior Planets, of which we can have but a teleſcopic knowledge. The next which comes into conſideration, is the *Earth*.

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THE

THE EARTH

IS the third Planet from the centre of the Solar Syſtem; is moſt open to our inveſtigation, and more particularly arreſts our attention; being the world we inhabit, a knowledge of its motions and dependencies naturally exciting the laudable curioſity of mankind, and filling the mind with a ſort of pious wonder and amazement.

This globe is a vaſt compound of earth and water, riding through the air with a moſt ſurpriſing celerity, though to our ſenſes devoid of motion; and, like the other Planets, its means of dependence is to us inviſible, and has long been a matter of philoſophical inquiry: This body's being ſupported in the air, and retaining its relative ſituation to the Sun and ſurrounding Planets, is an effect irrefragably declarative of the omnipotence of the Divine Creator; and a knowledge of its cauſe, is alike intereſting to rational religion and to philoſophy.

That ſublime philoſopher, Sir Iſaac Newton, conſidered this inveſtigation an object highly worthy of his profound attention, and while he was meditating on the phenomenon, the gracious Author of Nature (as it were to enlighten the minds of men) pointed out the cauſe of ſo myſterious an effect: In one of her ſimple performances was diſplayed to this admirer of her works, that operative principle which he afterwards denominated Gravitation.

While this great man was walking in his garden, and exploring the cauſe of the Earth's ſuſpenſion, an apple fell from a tree by which he was paſſing, and, as if by predeſtination, this ſeeming caſualty attracted his attention: conſcious of the ſimplicity of the operations of Nature, he inquired within himſelf the cauſe of that body's falling to the ground; for as, by the rotation of the globe, we ſometimes appear to be at the top of the earth, and ſometimes at the oppoſite part, there ſeemed a deficiency in philoſophy in accounting for the cauſe of the returning of earthly particles to its ſurface; he enlarged upon the phyſical inuendo, and founded upon this ſimple event, a baſis for his ſublime law of Gravitation.

That all things on our Earth, poſſeſs a gravitating principle or inclination to a centre, is exemplified by the ſimple experiment of throwing a ball into the air, which, after it has loſt its appulſive force, or that which was requiſite to caſt it upwards, will immediately return to the earth, and, but for the denſity of its ſurface, would penetrate to its centre as the centre of gravity or attraction. It is therefore this attractive power which cauſes all things on the face of the earth, to adhere to its ſurface; for as our globe is for ever turning round upon its axis (and that with great rapidity), they would, were it not for this gravitating principle, be thrown off; indeed the birds which fly, only retain their power of aſcenſion or ſuſpenſion in the air, as long as they keep their wings in motion, for when that motion ceaſes, the earth's attractive quality ſhews its power, and brings them to its ſurface; and the velocity with which objects return to the earth from any elevation, is in proportion to their ſpecific gravities, and conſequent reſiſtance or non-reſiſtance to the buoyant atmoſphere. But in proportion of ſpace to time, bodies are diſcovered to deſcend according to the following arithmetical progeſſion, viz. that if they fall one yard in the firſt ſecond of time, they will fall 3 yards in the ſecond; 5 in the third, and ſo on with this multiplying progreſs, according to the ratio of 3, 5, 7, 9, 11, &c. ſo that in the courſe of twelve ſeconds, a body in deſcent will have fallen 144 yards; wherefore (as it appears) the ſpace through which a body falls, is equal to the ſquare of the time it employs in that deſcent.

To exemplify the influence of gravitation more fully, we will ſuppoſe four perſons placed in four direct opponent meridians, or diametrically oppoſite parts of the world (ſo that, were they to meet in the centre, they would be all four foot to foot), and they were to fire each a ball immediately vertical, or towards that part of the heaven which is directly over their reſpective heads; theſe balls, after their projectile force is expended, or that cauſe which gave them motion ceaſes to act, will immediately ſhew a gravitating propenſity to the earth's center; ſo that ſhould one fire due North, another due South, one due Eaſt, another due Weſt, notwithſtanding their oppoſite directions, theſe balls will, in their return, all incline to one common centre. This proves the power and elucidates the principle of terreſtrial Gravity, or inclination of particles to the Earth's centre: and in like manner as particles on the Earth's ſurface, are inclined to its centre, ſo are the Earth and ſurrounding Planets inclined by the laws of gravitation to their centre of gravity. And nothing appears more conſiſtent with human reaſon, or congenial to divine philoſophy, than defining the Sun as the centre of Gravitation, ſince it is the body round which all our Planetary Orbs are obſerved to revolve, with a due obſervance of their reſpective diſtances: but from the active principle of Gravitation alone it appears, that all the Planets would, through its impulſe, ruſh to the Sun as their centre of attraction; and this event, in all probability, would take place, were it not for the power of the other principle, called * Repulſion, acting in oppoſition to that of Gravitation: ſo that it is the repulſive power of the Sun (a quality inherent in fire) oppoſing the impulſe of gravitation, which confines the Planets in their reſpective orbits, and gives them their projectile force or revolving motion.

The rotary influence which the powers of Repulſion and Gravitation, acting in oppoſition to each other, have upon ſpherical bodies, is practically elucidated by ſimple and elemental experiments:

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* For the diſcovery of this power, called Repulſion, the world is not indebted to the immortal author of the principle of Gravitation, but to an ingenious Philoſopher, of whom I made mention when treating of the Sun. In this particular indeed, Sir Iſaac was deficient, ſubſtituting for it a power which he termed *projectile force*, not capable of bearing that particular elucidation which Repulſion affords; whoſe operative power is as copiouſly evinced, by natural effects, as the principle of Gravitation. Though this was a power unknown to Sir Iſaac, yet, from his reſearches into Nature, he opened to mankind a ſource whence have ſprung this and many other ſubſequent and important diſcoveries.

ments: Firſt, by placing a ball upon the jet of a fountain, the ball will naturally, by the power of gravity, incline downwards towards the Earth, while the repulſive force of the water will impel it upwards, and reſiſt its gravitation: thus the counteraction of theſe two powers will keep it ſuſpended in a particular place, proportioned to the repulſive force of the water, and the magnitude and conſequent gravity of the body.

In like manner is our Earth acted upon by theſe two principles, Gravitation and Repulſion, and reſtrained in its limited orbit. Gravitation inclining it to preponderate to the centre of the ſyſtem, while the repulſive power of the ſolar fire, reſiſts this gravitating tendency, and confines its locality to a particular orbit.

Though the ball (this repreſentative of the Earth in the experiment) is confined to a particular ſituation, yet it does not remain inactive, but is perpetually turning round, or making a rotation upon its axis; ſo that the repulſive force of the water counteracting the gravitating propenſity of the ball, operates the ſame rotary motion on it, as the repulſive power of the Sun, does in reſiſting the gravitating propenſity of our Earth.

The experiment is equally efficacious in ſubſtituting an aërial for this aqueous element, or by paſſing a current of air through a tube; the rotary motion and ſuſpenſion will be given to a ball placed at its orifice, and produce a ſecond elemental experiment of the motion produced by the contention of theſe two powers.

Again, the like effect is produced with the native repulſive influence of Fire, by placing a light ball upon the end of a tube, through which a rapid current of that elemental fluid paſſes; and conſequently exemplifies the experiment, upon the ſame elemental principles by which our Earth is operated upon.

The Orbit of the Earth, or that ſituation in which theſe counteracting properties confine it, is diſtant from the Sun about 96 millions of miles, in which it performs its revolution once in 365 days, 5 hours, 48 minutes and 55 ſeconds, conſtituting our year; although, for convenience, we only reckon 365 days in it, whereby we ſuſtain annually a loſs of the extra hours, &c. but make up the deficiency, by adding one day to every fourth year, commonly known by the name of Biſſextile, or Leap Year, omitting or paſſing over one in every century; the additional day is always placed at the end of February, making that month to conſiſt of 29 days, and the year of 366. The velocity with which the Earth moves round the Sun, is at the rate of above 68 thouſand miles per hour: accordingly, as there are 8,765 hours in the year, the length of its annual revolutionary courſe is above five hundred millions of miles.

The appearance which our Planet may have when viewed from any of the others, we can only conjecture to be in proportion to its bulk and diſtance.—To the Lunarians, or people inhabiting the Moon, we are authorized to ſuppoſe it appears conſiderably larger than that ſatellite appears to us; for though it is impoſſible for man to migrate to other worlds, and ſatisfy himſelf by ocular demonſtration of the appearance which our Earth really makes, when viewed from one of them, yet the ſuppoſition is rational, and partly ſanctioned by the obſervations which our aëranauts have made in their balloon excurſions; who, when they aſcended to a conſiderable height in the atmoſphere, ſaw the face of the earth become more indiſtinct, putting on a bright, luminous appearance, and the higher they roſe, the change became more viſible; wherefore there is every reaſon to believe, that if they could have aſcended ſtill higher, this luminous or planetary appearance would have become infinitely more conſpicuous.

But as the air is conſiderably more denſe and heavier at the ſurface of the Earth, than it is in the higher regions, where it becomes more and more rarefied in proportion to its diſtance from the Earth, ſo it prevents the aſcenſion of a balloon (the only aërial vehicle we have) beyond a certain limited extent, and thereby fruſtrates our deſire of ſeeing the Planet we inhabit with its full luminous aſpect.

Gas, or inflammable air, with which balloons are uſually filled, is the lighteſt of all aëriel matters hitherto diſcovered, and the one found beſt calculated to promote aſcenſion; but though conſiderably lighter than the air we breath, yet its efficacy has been proved only capable of acting to a certain altitude; for as the atmoſphere becomes progreſſively lighter in proportion as the balloon aſcends, it will naturally, when it arrives at that degree of aſcent where the atmoſphere poſſeſſes nearly the ſame degree of rarefaction as that within the balloon, arreſt its further progreſs, and thus arrive at its *ne plus ultra* of aſcenſion.

This atmoſphere, which is a light, fluid, thin, elaſtic matter, ſurrounding our Earth and freely filling all its pores, extends to the height of about 45 miles; it is ſo dry that it never can congeal as water does into ſnow or ice: its elaſticity cauſes the vibration from ſonorous bodies to our ears, diſſeminates odours to our olfactory nerves, and refracts the rays of light to our viſual ſenſes in coming from the Sun: hence alſo the lungs receive a freſh ſupply of that vivifying ſpirit which animal life deſtroys in reſpiration; it expands greatly in the preſence of the Sun, condenſes in his abſence, and produces all thoſe changes in the vegetable creation which the various ſeaſons ſo beautifully diſplay; it is an univerſal cement for bodies, and a menſtruum for reducing things to other forms: through the elaſticity, and rarefaction of the Earth's atmoſphere, great quantities of waters are exhaled from the ſeas, rivers, lakes, &c. In this the Sun is the intenſe agent, particularly where he is vertical, or the atmoſphere is rare; theſe exhalations form clouds conſiſting of aqueous and ſaline particles, and by the agency of the wind, they are diffuſed all over the face of the Earth; they float up and down till by combination they form a body ſpecifically heavier than the medium in which they float; they then deſcend freely, and in their deſcent are diſunited by the air and formed into pellucid gems, which we call drops of rain: Of the ſame compoſition are fogs and miſts near the Earth's ſurface, which want nothing to make them clouds in the higher regions of the air but a more denſe atmoſphere to ſwim in: when the clouds or drops of rain deſcend through cold regions of the atmoſphere, or are intercepted by freezing winds, then warmer air, they firſt gently congeal, then gently thaw, and adhere together, falling into fleeces of ſnow; and when the particles of the atmoſphere are more nitrous, or the cold more intenſe, inſtead of becoming ſnow, they form hail.

Since our atmoſphere only extends forty-five miles, there is a vaſt ſpace between us and the Sun; but of what ſpecies, the ablities of man are inſufficient to inveſtigate; Sir Iſaac Newton has defined it, an Ætherial Medium, infinitely more pure and refined than our atmoſphere, and calculated to convey to the ſurrounding worlds that light and heat which is diffuſed from the Sun.

The true places of the Cœleſtial Objects could not be deſcribed with any accuracy from obſervations made on the Earth's ſurface, unleſs its figure and magnitude had been previouſly aſcertained; and in like manner, without this knowledge, computations made from the heavenly bodies (ſo indiſpenſable in Navigation for diſcovering ſituations on the Earth's ſurface), could not be depended upon. Therefore, firſt the figure of the Earth was an object of ſpeculative enquiry among the ancient Philoſophers; and though there were ſome who diſſented from the idea, yet it was the prevailing opinion, that it was of a ſpherical figure, becauſe bodies like our Earth, inured to a rotary force, will naturally aſſume a rotundity.

But modern Philoſophers have aſcertained the truth, not by mere ſpeculative reaſoning, but by ſubſtantial evidence derived from actual obſervations: For, by the laws of optics, it is acknowledged, that if any body in all ſituations projects a circular ſhadow (which is the caſe with our Earth), that body muſt be globular; as we find during a Lunar eclipſe, which is cauſed by the Earth's ſhadow paſſing over the Moon, that whether the ſhadow is projected towards the Eaſt or Weſt, the North or South, under every circumſtance it is circular; therefore, the body which caſts that ſhadow is doubtleſs ſpherical: beſides, Navigation adduces many inſtances in proof of the Earth's globularity; for, if at the ſea-ſide we ſtand upon the beach, awaiting a veſſel which we know is about to arrive, the firſt part of her we ſhall be able to diſcern, will be her main-top-gallant-maſt (the convexity of the Earth then impeding any further view of her); but as ſhe advances towards us, we view her progreſſively downwards from the main-top-maſts, ſeeing all her maſts and ſails before we ſee her hull; at length, as ſhe approaches us, the hull or body of the veſſel becomes viſible, and apparently to ariſe gradually out of the water.

So, on the other hand, when a veſſel is departing from the ſhore, we firſt loſe ſight of her hull, then of her main-ſails, afterwards of her top-ſails, and laſt of all her top-gallant ſails diſappear. Yet, the rotund figure of the Earth, is even more conſpicuouſly diſcerned by the meeting of two veſſels at ſea: For, ſuppoſe them firſt at ſuch a diſtance, that they can but juſt ſee one another through teleſcopes from their main-top-gallant-maſt heads, thoſe on deck will be inconſcious of any ſhip being near them; but as they advance towards each other, their reſpective top-gallant ſails will juſt become viſible to them, while the perſons aloft will be able to diſcern the great body of ſails; and when thoſe below firſt view the mainſails, the others will ſee the hull of the veſſel: wherefore, it is on account of this convexity of the Earth, that Mariners in diſtreſs always go to the maſt-head to eſpy land.

But nothing more ſtrongly confirms the convexity of the Earth's ſurface, than the voyages performed by our great Circumnavigators, who have ſtood round the world in one particular direction, and returned to the ſame point from which they departed, without varying their courſe.

Philoſophers having aſſured themſelves of the globularity of the Earth, and by menſuration diſcovered its extent, they proceeded to form boundaries, whereby the ſituations of certain parts might be diſtinguiſhed and known: the meaſurement they divided into degrees and minutes; one degree containing 60 Geographical miles or minutes, (which are in extent equal to 69½ Britiſh ſtatute miles); and the circumference of the Earth, conſiſting of 360 degrees, which ever way it is computed. The imaginary lines which particularize certain extents, are either encircling the Earth, or paſs from one extremity to another; thoſe of the latter are the Axis, with its Poles; and the Meridional Lines: thoſe which encircle the various parts of the Earth, are the Equator, the Ecliptic, the Tropics of Cancer, and Capricorn: the Arctic and Antarctic Circles, with the parallel lines; all of which will come under our obſervation in due order. Firſt, *The Axis*.

THE AXIS

Is that line ſuppoſed to be drawn directly through the centre of the Earth, from North to South, upon which its diurnal motion is performed, completing one rotation thereon in 24 hours; thereby producing to us the welcome returns of Day and Night: each end of this Axis is called its Pole, either North or South, according as it is North or South of the Equator.

This Axis is well repreſented upon artificial globes by axles, upon which they turn round in a correſpondent manner to our Earth's rotation upon its Axis: the Earth moves upon this Axis from Weſt to Eaſt, which cauſes the appearance to us of the heavenly bodies moving from Eaſt to Weſt; and although the days in Summer appear to us longer than they are in Winter (as will be accounted for hereafter), yet the Earth never alters its motion, but occupies the ſame ſpace of time in performing its rotation during each of theſe Seaſons.

The other lines which run parallel with this Axis, are *The Meridional Lines.*

THE MERIDIONAL LINES,

WHICH are uſually upon common Globes (but may be multiplied at pleaſure) twenty-four in number, diſtant from each other 15 degrees (or one hour in time): theſe are imaginary Lines upon the Earth's ſurface, not the ſame with every nation; for, as they are the lines by which the longitudes of places are diſtinguiſhed, they vary according to the place from which different nations calculate their Longitude, which is called the Firſt Meridian, and has paſſed by ſome over one place, and by ſome over another.

Ptolemy is ſaid to have placed it at one degree beyond the Canary Iſlands; after America was diſcovered, it was placed at St. Nicholas, one of the Cape-de-Verd Iſlands; then by Hondius, it was fixed at St. Jago; afterwards, by Mercator, at Corvo, one of the Weſtern Iſles; the Dutch reckon from Teneriffe, one of the Canary Iſlands; the French placed it in the middle of Faro, the weſternmoſt of the Canaries, and ſometimes at Paris; whereas, the Engliſh calculate theirs from a line ſuppoſed to be drawn from Pole to Pole, and paſſing directly through the Obſervatory in Greenwich Park. At every 15 degrees diſtance from this firſt line, ſimilar ones are ſuppoſed to be drawn each way, till they amount to 180°, which line will be found in that part of the world directly oppoſite to the firſt Meridian: ſo that, when we have the North before us, all that part of the globe on the right hand of the firſt Meridian is the Eaſtern Hemiſphere, and every ſituation between it and 180°, is ſaid to be in Eaſtern Longitude, ſo many degrees and minutes, according as it is diſtant from the firſt Meridian: whereas, all that ſpace on the left hand of that Meridian, and between it and the oppoſite, is the Weſtern Hemiſphere, and places therein accounted Weſtern Longitude: For inſtance, as this line comparatively occupies no ſpace, the greateſt part of England is to the left of it, and conſequently in weſtern longitude; whereas, we have only the entire Counties of Kent, Eſſex, Norfolk, and Suffolk, that are in eaſtern longitude.

It is cuſtomary in the conſtruction of the artificial globes, to place the firſt point of Aries at the London Meridional Line, which, together with the oppoſite line paſſing through the beginning of Libra, is called the Equinoxial Colure; becauſe the Sun, when it comes to either of theſe ſigns, croſſes the Equator: when it arrives at Aries, it is travelling northward, and it is then the commencemencement of our Spring, whence it is called the Vernal Equinox; and when it has reached Libra, it is declining ſouthward, and it is then our Autumn; wherefore, it is called the Autumnal Equinox.—Equinox ſignifying equal night and day, which it is in all parallel parts of the world, when the Sun arrives at either of theſe points: after each of theſe equinoxes, we have frequent ſtorms of wind at ſea, which are called Equinoxial Gales. That Meridian which paſſes through the beginning of Cancer, with its oppoſite, paſſing through the beginning of Capricorn, is called the Solſtitial Colure. The Sun arrives at Cancer in June, that is conſequently the Summer Solſtice; and he is at Capricorn in December, which is therefore the Winter Solſtice.

THE EQUATOR,

OR Equinoxial Line, is a circle round the Earth, dividing it again into two Hemiſpheres, called the Upper or Northern, and Lower or Southern; this circle paſſes at right angles with the meridional lines, and upon it their diſtances are reckoned on the globe: it is every way diſtant from either of the poles, juſt 90°.

When the Sun, Moon, or any Star, happens to be in that part of the heaven directly oppoſite to that line, they riſe due Eaſt and ſet due Weſt; this happens with reſpect to the Sun at both of the Equinoxes: every inſtant preſents ſome new part of the Equator to the Sun's centre, ſince by the Earth's rotation, it moves in the following proportionate ſucceſſion, viz.

°	′			*H.*	*M.*	*S.*	
360°	0′	of the Equator move in		24	0	0	of time.
15	0	-	-	1	0	0	
1	0	-	-	0	4	0	
0	15	-	-	0	1	0	
0	1	-	-	0	0	4	

and in like proportion for every intermediate number of degrees.

THE

THE ECLIPTIC

IS a graduated circle, croſſing the Equator obliquely at Aries and Libra, forming an angle with it of 23½ degrees, or is ſo diſtant from it at its remoteſt parts, which are Cancer and Capricornus. The Ecliptic and Zodiac form a conjunctive circle, the Zodiac bearing the ſigns, and the Ecliptic the degrees and minutes thereof. It is divided into twelve parts, denominated Signs, being diſtinguiſhed by ſome conſtellation; theſe ſigns contain each 30°, making in the whole 360°, the circumference of the Earth. The Northern Signs or thoſe north of the equator, are Aries, Taurus, Gemini, Cancer, Leo, Virgo; the Southern are Libra, Scorpio, Sagittarius, Capricornus, Aquarius, and Piſces. The four Cardinal Points, are the firſt degrees of Aries, Cancer, Libra, and Capricornus. When the Sun is in or near the Equinoxes, that is, the entrance of Aries or Libra, the days lengthen or ſhorten very perceptibly, becauſe the Ecliptic is in thoſe places leſs oblique to the Equator; but when the Sun is near to, or juſt entering the Solſtices, viz. the beginning of Cancer and Capricornus, the days then ſcarcely ſeem to increaſe or diminiſh; becauſe, in thoſe places, the Ecliptic is almoſt parallel to the Equator.

The Ecliptic derived its name from the Eclipſes, both ſolar and lunar always happening upon this line; it is alſo called the Via Solis, or Sun's Way, becauſe the Earth, in its revolution round the Sun, revolves upon this circle, that is, always expoſes ſome part of it to the Sun's face: the time employed in the performance of one revolution, is called a Tropical or Solar Year, conſiſting of 365 days, 5 hours, 48 minutes, 55 ſeconds, and conſtitutes our civil year, as before deſcribed.

The Ecliptic's extreme diſtance from the Equator, is, as before obſerved, 23½ degrees North and South, where it unites with the *Tropics.*

TROPICS.

THE northern, the Tropic of Cancer; the ſouthern, the Tropic of Capricorn: theſe are called the boundaries of the Sun's courſe, becauſe he never exceeds them, that is, he is never more North than Cancer, or South than Capricornus.—When he arrives at Cancer he declines ſouthward; and when he has reached Capricornus, he then advances northward, invariably obſerving the Tropics as the limits of his extent.

There are two other circles parallel to the Tropics, called the

ARCTIC and ANTARCTIC CIRCLES.

THE Arctic being the northern Circle, and the Antarctic the ſouthern, each diſtant from the Tropics 43 degrees, and from the Poles 23° 30'.—Theſe Circles are alſo called the Polar Circles, becauſe of their vicinity to the Poles, or rather, becauſe the Poles of the Ecliptic unite with them. The North Polar Circle, by paſſing through the conſtellation Arctos or the Bear, obtained the name of the Arctic Circle; and the South Polar Circle, by being its oppoſite, was conſequently called the Antarctic Circle.

THE ZONES

ARE large ſpaces or tracts of land and water on the Earth's ſurface, ſurrounding the globe, and dividing it again into five diſtinct parts; there being one Torrid, two Temperate, and two Frigid; they are bounded by the Polar and Tropical Circles: firſt, the Torrid Zone, is that ſpace between the Tropic of Cancer and the Tropic of Capricorn, occupying an extent of 47 degrees in breadth all round the Earth.

This Zone is the hotteſt part of the terrene world, becauſe the Sun is always vertical, or immediately over head in ſome part or other of it; this happens indeed twice annually in every part, except at the Tropics, and at noon-day, in that place within this Zone where the Sun is vertical, the inhabitants have no ſhadows, the ſolar rays coming perpendicular upon their heads, thereby cauſing an intenſe heat. Some parts of Aſia, Africa, and America, are within this zone, but no part of Europe.

The two Temperate Zones are thoſe terraqueous ſpaces between the Tropics and the Polar Circles, the North Temperate being the ſpace between the

Tropic of Cancer and the Arctic Circle; the South Temperate between the Tropic of Capricorn and the Antarctic Circle; theſe Zones are juſtly termed temperate, ſince they neither endure the inſalubrious power of too warm a Sun, nor are expoſed to the chilling miſery of perpetual froſt; but taſting ſucceſſively the frigidity of Winter, and the warmth of Summer.

The other two Zones are thoſe ſpaces which occupy the diſtances between the Polar Circles and their reſpective Poles, and are appropriately called the Frigid Zones, their ſeas and rivers being generally frozen up, and their land covered with ſnow; ſo clogged are their ſeas with mountains of ice, that our Navigators have not been able to advance nearer than within ten degrees of the South Pole, becauſe the Southern Hemiſphere, being compoſed more of water than the Northern, is thereby more expoſed to condenſion, and conſequently more loaded with ice, which confines the limits of Navigation in that part; no land has hitherto been diſcovered within the South Polar Circle, nor is any ſuppoſed to be there. The North Circle is navigable, but the intenſe frigidity of its climate has proved fatal to many navigators who have endeavoured to diſcover a paſſage thereby to the Eaſtern ſeas. Parallel to the Tropical and Arctic Circles, are lines, deſcribing the Earth in ſmaller diviſions; they are uſually diſtant from one another upon the common globes each 10 degrees, and are nine in number on either ſide of the Equator, making up the diſtance thence to the Poles, which is 90 degrees: On theſe lines the Latitude is reckoned North or South, according as it is North or South of the Equator.

* * *

OF THE EARTH'S ANNUAL AND DIURNAL MOTIONS.

THE Earth, as I obſerved before, performs a rotation upon its axis in the ſpace of 24 hours, and the meridional lines, which are generally 15° apart, anſwer in time to one hour; ſo that thoſe people who inhabit that part of the globe which lies 15° to the eaſtward of us, will ſee the Sun one hour before he arrives to our view, therefore it is in the meridian with them, or twelve o'Clock at noon, while with us it is but eleven, and with thoſe who live 30 degrees to the Eaſt of us, it will be one hour P. M. or one o'clock in the afternoon, and ſo in proportion to their diſtance eaſterly; whereas the inhabitants of all the places to the weſtward of our meridian will have the Sun later than we, in the ſame proportion to their diſtances, as thoſe have it ſooner who live to the eaſtward. When our meridian is oppoſed diametrically to the Sun it is noon or mid-day with us; but as we perpetually move from Weſt to Eaſt, the ſun bears 15° more weſterly every hour, and in the courſe of a few hours from noon we ſee him decline below the Weſtern Horizon, or ſet, and in twelve hours from his appearance in our meridian, he is giving day to the oppoſite part of the globe, while we are left in midnight; but after bearing this ſolitude for a few hours the dawn of day arrives, and by this continued rotary motion, he again reaches our meridian, and thus completes the Aſtronomic day, having paſſed over 360 degrees in 24 hours; but we reckon our common or civil day from midnight to midnight. Though the Earth moves round inceſſantly upon its axis, the Sun does not retain the ſame poſition in the heavens at the termination, that he occupied at the commencement of that diurnal rotation, becauſe of the Earth's duplicate motion; for beſides the performance of the rotary one already deſcribed, it is perpetually moving forward in its revolutionary courſe, expoſing (through the obliquity of the Ecliptic) either a more Northern or Southern part of it to the Sun's centre one day, than it preſented the day before, the latter thus ſeeming to advance in the Ecliptic nearly one degree per day, according as it is in North or South declination: conſequently his apparent ſituation in the heavens cannot be the ſame one day that it was the preceding.

It appears a ſingular circumſtance, and will ſurprize the juvenile mind to hear, that the Earth is farther from the Sun during our ſummer than it is during our winter; for judging only from the proportion of heat, we might, when we feel the power of his rays ſo ſenſibly as in Summer, ſuppoſe the Earth much nearer to him; but by obſervation, the contrary is diſcovered to be the fact, and is very philoſophically accounted for in this manner: we inhabit the northern hemiſphere, which part of the globe is oppoſed to the Sun during the whole of our ſummer half year, and this northern hemiſphere contains a greater portion of land than the ſouthern, viz. in ratio of about 3 to 1, and as land evidently poſſeſſes a more repulſive property than water, our Earth, by imbibing ſo much heat in ſummer, adds to the repulſion of the Solar rays, and is thereby repelled to a diſtance ſuperior to that which it held in winter; ſo likewiſe when the Sun has arrived at the Autumnal Equinox, and gets into ſouthern declination, he is then vertical in that hemiſphere where water occupies the greater ſpace, and as this element is not ſo repellent as land, gravitation preponderates; ſo that the Earth, here loſing that repulſion it had when the land was oppoſed to the Sun, gradually advances towards it through the prevailing influence of gravitation. As by the repulſive power, the Earth is eloigned or repelled to a greater diſtance from the Sun during its northern than ſouthern declination, it conſequently will, during its northern declination, deſcribe a larger part of its orbit than during its ſouthern, which is evident from its being about ſix more days in this declination than in the other;

it hereby is evident alſo, that the orbit of the Earth is not a perfect circle, but of an elliptic or oval form; but ſo immaterial is the difference, that in proportionate delineation it would be ſcarely perceptible.

OF THE MOON.

THIS ſatellite, a chearful companion to our Earth, is a conſpicuous and ſplendid ornament in the cœleſtial ſphere, and when, by our rotation, we are deprived of the ſun's enlivening rays, furniſhes us with, as it were, an artificial day. The light which ſhe emits, is not native or her own, but is only the reflection of that which ſhe receives from the Sun, ſhe being, like the planets, an opake body, ſhining with borrowed luſtre: from her proximity to us, ſhe appears in bulk nearly equal to the Sun, and far ſurpaſſing that of any of the planets; yet the reverſe is the fact, ſhe being actually leſs than Mercury, the ſmalleſt of thoſe planets; her ſize when compared to that of the Earth, is as 3 to 11.

The diameter of her diſk is 2,180 miles, and the diſtance of her orbit from the earth's centre 240,000. The time ſhe employs in going round the Earth, reckoning from change to change, is 29 days, 12 hours and 44 minutes, moving at the rate of about 2,300 miles per hour: while ſhe is making this circuitous tour or revolution round the Earth, ſhe undergoes very conſiderable changes; when ſhe arrives at our meridian at midnight, ſhe is in that part of the heavens which is directly oppoſite to the Sun, in which ſituation her appearance to us is that of a complete circle, and we then call her Full Moon; as at the ſame hour of each ſucceeding night, we behold her more to the eaſtward, her luminous aſpect becomes more deficient on the weſtern ſide, and in about 7 days, 8 hours, ſhe comes to the meridian at about 6 in the morning, having then the appearance of a ſemicircle, with the convex, or round edge, turned towards the Sun; when ſhe is in this ſtate, ſhe is called Half-moon, becauſe only half of her enlightened part is turned towards us: ſtill moving on to the eaſtward, her illumined part becomes continually more reduced, till at length it is altogether inviſible to us; this happens about 14 days after ſhe appeared ſhining with a full face, and the reaſon of her inviſibility is, that ſhe has, in her revolution, arrived at that part of her orbit which is between us and the Sun, when her dark ſide is turned towards us; in this ſtate ſhe is termed in conjunction, and is with us by day; whereas, when full, ſhe is ſaid to be in oppoſition, and is only ſeen at night. After ſhe has remained in obſcurity about four days, ſhe appears to us as a new Moon, becoming viſible to us in the evening a little to the eaſtward of the Sun, in a figure of a fine creſcent, with the convex edge turned from the Sun: ſtill continuing her eaſtern courſe, the creſcent becomes more replete, and in about 7 days, 8 hours, ſhe comes to the meridian at about ſix in the evening, and again aſſumes that appearance which we denominate Half-moon. Advancing ſtill to the eaſtward, her illumined part becomes more viſible, and in about 29½ days from the former Full Moon, ſhe reaſſumes the like appearance, and ſhines upon her Earth with refulgent luſtre, being then again in oppoſition to the Sun.

The various appearances of the Moon are called its Phaſes, and her progreſſive ſtates are commonly diſtinguiſhed by Quarters, viz. from new to Half-moon is the firſt quarter; from half to full the ſecond, in which ſtage ſhe is gradually encreaſing; from full to half again is the third, and from thence to new is the fourth, or laſt quarter, in which progreſs ſhe is continually decreaſing.

Though ſometimes we ſee but half of the Moon, and ſometimes much leſs than half of her, it does not follow, that thoſe are the only parts which are then illumined by the Sun; on the contrary, one half of her is always enlightened, or a Full Moon, is ever ſhining ſomewhere; but the cauſe of our ſeeing ſuch various poſitions of her enlightened body proceeds from the ſituation of her orbit, ſhe paſſing round our Earth with her bright ſurface always turned towards the Sun, ſo that we have ſometimes a back view, ſometimes a ſide view, and ſometimes a full view of her illumined hemiſphere. When ſhe is in conjunction, or is New Moon to us; then to the Lunarians, or people inhabiting that ſatellite, our Earth appears in oppoſition, and ſhines on them with a full face; but from its magnitude, diſtributes proportionally more light than the Moon imparts to us.

The Moon has a trifold motion; firſt, a central one upon its own axis; ſecondly, a revolutionary round our Earth, which ſhe regards as her centre; and, thirdly, an irregular motion which ſhe makes, by being carried with our Earth in its revolution round the Sun: from this two-fold revolution, round our Earth and the Sun at the ſame time, the courſe ſhe makes is a cycloid (or looped circle) ſhe being alternately within and without the Earth's orbit.

Though this ſatellite is generally ſuppoſed to be an habitable world, yet we are well aſſured, that it is not ſo ſuitable to people of our conſtitution, as the Planet on which we dwell, the variation of the climate aſſerts it; for when the Moon is within the Earth's orbit, ſhe is nearer to the Sun than the Earth is, and conſequently, we muſt ſuppoſe, endures a greater heat; whereas, when ſhe is without our orbit, ſhe is more diſtant from the Sun, and conſequently colder; ſo that there is a regular ſucceſſion of ſummer and winter, every month, for the people inhabiting this ſatellite to endure.

Though there have been many opinions concerning the quality of the Moon, that which has generally prevailed is, that it is of a terreſtrial nature; but a knowledge of the ſpecies of its compoſition, and the kind of inhabitants it contains, is a deſideratum more to be wiſhed for than expected.

Some parts of the Moon's diſk appear to the naked eye darker than others, which Aſtronomers imagine to be deep pits or caverns therein, whoſe ſhadows fall within themſelves; ſome indeed are moveable, theſe are conceived to be the ſhadows of mountains, being ſeen ſometimes in one poſition, and ſometimes in another, according as the Moon is either eaſtward or weſtward of the Sun; the lucid or bright parts of the Moon are ſuppoſed to be Continents, Iſlands, and Peninſulas; but thoſe which are brighter than others, to be very high denſe rocks and promontories.

Some of our modern Philoſophers are of opinion there are no ſeas in the Moon, and have converted into vallies and pits what the ancients conceived to be water; but this hypotheſis is not general.

The mode by which this ſatellite is retained in its orbits, is a pleaſing elucidation of the counter actions of the principles of gravitation and repulſion; for in the courſe of its periodical revolutions it falls into two poſitions, where the active principles of theſe powers are particularly demonſtrable; theſe are, when ſhe enters her ſecond and laſt quarters; in the firſt inſtance ſhe is behind the Earth, in their common revolutionary courſe, and though the Earth moves in its orbit at the rate of 68,243 miles per hour, the Moon preſerves the ſame motion, following him at the like rapid rate, and adhering to him by the laws of gravitation, with a due obſervance of her orbicular diſtance. When ſhe is in that part of her orbit wherein ſhe enters her laſt quarter, ſhe is then in an exact oppoſite poſition with reſpect to the Earth, and though ſtill ſhe preſerves her relative diſtance from it, yet, inſtead of following it in their joint courſes, ſhe is advancing before it with the ſame progreſſive motion; and in this poſition the action of repulſion is particularly exemplified; for here the Earth repells the Moon before it, whereas in the ſecond quarter it attracts it in ſucceſſion.

To the Moon is chiefly aſcribed the cauſe of the Tides, for, according to Sir I. Newton, the waters underneath the Moon will be attracted up in a heap, and ſo likewiſe will the waters on the oppoſite ſide of the globe, but then more feebly, and that after they have been ſuſpended for a ſhort ſpace of time, they will again fall; this flux and reflux of the Earth's waters, is occaſioned twice in every twenty-four hours, and is in other reſpects materially influenced by the Moon, ſometimes flowing more conſiderably than at others, and are then called a Spring Tide.

This agitation of the waters of the Earth is peculiarly advantageous for navigation, and an infallible preventative to putrefaction. It is ſaid of Ariſtotle, that after laborious ſtudy, he, deſpairing to diſcover the true cauſe of the tides, had the folly, in ſpite of all his philoſophy, to plunge himſelf head-long into the ſea.

OF ECLIPSES.

BY Eclipſe (Aſtronomically) is meant a temporary concealment of ſome of the Cœleſtial Orbs, which inviſibility is cauſed by a privation of the Sun's light.

Any opake body that is expoſed to the light of the Sun, will naturally caſt a ſhadow behind it; this ſhadow is evidently a ſpace deprived of light, into which ſpace if another body falls it will not be viſible for want of light; the body thus falling within the ſhadow is ſaid to be eclipſed: ſo that the Earth and Moon, which are both opake or dark bodies (they receiving all their light from the Sun), do each of them caſt a ſhadow behind them, therefore which ever is the outermoſt or moſt diſtant from the Sun, and paſſes through the ſhadow of the other, is the orb eclipſed, as by the interpoſition of the interior one, it is deprived of that illumination which the Sun would otherwiſe beſtow on it: hence it is that the Lunar Eclipſe is a privation of the Sun's rays acting on the Moon, by the interpoſition of the Earth: whereas a Solar Eclipſe is cauſed by an intervention of the Moon, which precludes our view of the Sun. So it appears there are three bodies requiſite to form an Eclipſe, the Sun, the Moon, and the Earth, or the body giving light; the opake body cauſing a ſhadow, and the other body falling within that ſhadow.

A TRANSIT

IS performed in like manner as an Eclipſe, but relates only to the Planets: it is the paſſage of one of theſe Orbs acroſs the Sun's face or diſk, and obſcures the light of the Sun in a very ſmall degree, wherefore it cannot be ſaid to eclipſe it; the only Solar Tranſits viſible to us, are thoſe performed by Mercury and Venus; as they are the only Planets within our orbit, no other can paſs between us and the Sun: when making their Tranſit they appear but as dark ſpots croſſing the Sun's diſk, which proves them to be opake bodies, for that part which receives no light, is turned towards us.

The exterior Planets ſometimes make a Tranſit behind the Moon, when they are concealed by the brightneſs of her body; but have a pleaſing appearance when returning to view from their occultation by this ſatellite.

I NOW come to treat of the exterior Planets, or thoſe whoſe Orbits are without the Orbit of the Earth, and of which there are four, viz. *Mars*, *Jupiter*, *Saturn*, and the *Georgium Sidus*. That which is next in rotation from the Earth, is the Planet

MARS,

WHO, as he deſcribes a greater circle in going round the Sun than the Earth does, has conſequently a longer year, it being nearly equal to two of our's; but the length of his day and night, is nearly as analogous to our's as Venus's is, ſince by obſervation he is diſcovered to rotate upon his axis once in 24 hours and 40 minutes. This planet is conſiderably leſs than our Earth, and is unattended by any Moon or Satellite, wherefore, from its being at a greater diſtance from the Sun than we are, and the conſequent deficiency in the power of its rays at that extent, it is ſubject to nights of greater gloom, which, with its more chilled orbit, renders it in every reſpect a Planet inferior to the Earth.

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As a Star, he appears much ſmaller than any of the other Planets, and is eaſily diſtinguiſhed by his red or fiery aſpect; to account for which appearance (peculiar to Mars alone) Aſtronomers have aſcribed to it a denſity of atmoſphere ſuperior to that which ſourrounds our Globe, and which does not admit or reflect the Sun's rays ſo clearly as if the atmoſphere was more rare: inſtances frequently occur on Earth to prove what a peculiar ruddy face the Sun or Moon will have when viewed through a fog, which is itſelf a denſe atmoſphere, and therefore authorizes the conjecture with reſpect to Mars.

There are ſome dark ſpots viſible on the diſk of this Planet when viewed through a teleſcope, whence Philoſophers ſuppoſe it to be of a terraqueous nature; but, like the other Planets, conjectures with reſpect to its People (if it is an babitable Globe) are vain and ſpeculative, and perhaps a knowledge thereof will ever ſurpaſs the extent of Man's circumſcribed ability.

OF JUPI-

OF JUPITER.

THIS Planet certainly lays claim to the title of Superior, ſince it not only greatly ſurpaſſes the Earth in ſize, but is attended by four Moons or Satellites; they are not diſcernible to the naked eye, but have a very pleaſing appearance when viewed through a teleſcope; they confer on this Planet a very eſſential light, of which, by being ſo remote from the Sun, it in all probability ſtands in need.

Jupiter is ſuppoſed to be 1,200 times larger than our Earth, and though of ſuch immenſity, performs a rotation on its axis in the ſhort ſpace of 9 hours 56 min. which is at the aſtoniſhing rate of 427 miles per minute; this velocity produces a very quick ſucceſſion of night and day to its inhabitants, yet, from its participating ſo little of the Sun's light, they cannot enjoy ſo perfect a day as we do; whereas the light which is imparted to it by its attendant Satellites far ſurpaſſes that which our Moon reflects on us when at full.

This Planet rides in an Orbit round the Sun between Mars and Saturn, and receives but one twenty-ſeventh part of the Sun's influence which the Earth imbibes; ſo that it is impoſſible to conceive with what kind of beings this Planet is inhabited. From the extent of Jupiter's orbit, he occupies nearly 12 of our years in performing one revolution round the Sun, being at the computed diſtance of above 400 millions of miles from that luminary.

When we regard him as a ſtellary object, his luſtre makes him eminent among the brilliant multitude; his appearance approaches to that of Venus, though he is not quite ſo effulgent; he appears to us (like her) ſometimes as a Morning and ſometimes as an Evening Star, with this obſervance, that when ſhe bedecks the morning ſky, he illumes the evening, and viſa verſa.

SATURN

WHICH, for ages, was conſidered as the moſt remote (in our ſyſtem) of the exterior Planets, and whoſe diſtance from the Sun was found to exceed 900 millions of miles, now yields the palm of ſuperiority to the new-diſcovered Georgium. Saturn is a globe of above 70,000 miles in diameter, though, to our obſervation, from his extreme diſtance, he ſeems but as a ſpangle in the Cœleſtial concave; he ſhines with a brightneſs between that of Mars and Jupiter, and emits but a feeble light: From his remoteneſs from the Sun, he occupies great length of time in deſcribing one revolution round it, which, upon obſervation, amounts to more than 29 of our years.

The Creator has attached to Saturn a phenomenon, which makes him eminent among the planetary tribe: it is a large circle or ring, which encompaſſes his body without being affixed to it; it has an atmoſpheric appearance, and is ſuppoſed to be 21,000 miles in breadth; but of its nature and properties, though various conjectures have been formed, no ſatisfactory information has hitherto reſulted from the obſervations of the curious. It is by ſome ſuppoſed to be a bright-coloured cloud, which perpetually encircles his body; and others are diffident in hazarding any opinion.

This planet has five Satellites, or lunar attendants, which impart to it a conſiderable portion of light, forming a ſubſtitution for the deficiency reſulting from its remoteneſs from the Sun. Theſe Moons, as well as the ring which environs Saturn, are inviſible to the eye unaſſiſted by a teleſcope; but impreſs on the mind a ſecret delight when viewed through one of theſe machines. It is not yet aſcertained, whether this planet performs a rotation on its axis; and therefore, the length of its day and night is as yet undetermined.

OF THE GEORGIUM SIDUS.

LONG, as I obſerved before, had Philoſophers aſcribed to Saturn the boundary of the Solar Syſtem, and ages had elapſed without the diſcovery of any other Planet, than thoſe already treated of; but the great improvements which have progreſſively been made in the ſcience of optics, and thereby the extenſion of man's viſual diſcernment, has opened to us a field of aſtronomic lore, never before ſurveyed by the mental eye; one of the chief of thoſe objects, whoſe exiſtence our anceſtors were unconſcious of, is the Orb of which we are now treating; and to the active genius of Dr. Herſchel, who has conſtructed a teleſcope with extenſive magnifying powers, is the world indebted for the diſcovery of a Planet beyond the orbit of Saturn; this diſcovery, ſo reputable to our aſtronomer, was made on the night of the 13th March, 1781, and in honour of his preſent Majeſty, he named it the Georgium Sidus (or George's Star), to perpetuate the memory of that royal patronage which enabled him profitably to inveſtigate a ſtupendous Firmament moſt gorgeouſly ſtudded by the King of Kings.

Watching with anxious care this offspring of his reſearches, ſo newly born to the aſtronomic world, he had ſoon the ſatisfaction to diſcern, that it had two ſatellites in its ſuite; this gratifying diſcovery added importance to the former, and confirmed his opinion of its being a Planetary Orb, in which claſs it is now generally conſidered: From its ſuperior diſtance, the remoteneſs of whoſe orbit is computed at twice that of Saturn's, the time it employs in the performance of its rotation is not yet aſcertained; by obſervation, its diameter is found to exceed 34 thouſand miles; its bulk, conſequently, greatly ſurpaſſing that of the Earth: he is calculated to occupy above 80 of our years in performing a revolution round the Sun. During the abſence of the Moon, this planet is viſible to the unaſſiſted eye, ſhining with a bluiſh light, and with no ſmall degree of brilliancy; but is difficult to be diſtinguiſhed from a fixed ſtar.

The orbicular line which this Planet deſcribes in its circumvolution round the Sun, is the boundary of our Syſtem; but, beyond that, is a range of ſtellary glories, of whoſe attributes we have as yet but a very imperfect knowledge. They are called *Fixed Stars.*

THE FIXED STARS

ARE ſo called, becauſe it cannot be diſcovered that they make any movement in the heavens, but only change their poſition to us as the Earth rotates on its axis. They are diſcovered to be at an immenſe diſtance from us, as well as from each other; from which it is conjectured, that as, by calculation, they are found to be too remote to receive any heat or light from our Sun, they are bodies poſſeſſing the ſame properties themſelves, and are "Suns to other worlds:" for though, from their extreme remoteneſs, no Planet has ever yet been diſcovered to revolve round any of them, yet it is ſuppoſed by the moſt learned in Aſtronomy, that they are the centric luminaries and vivifiers of an infinite range of ſyſtems like ours; and that thoſe which we call Stars, are the only parts viſible to us, becauſe they ſhine not with a reflected light, but with native luſtre, like our Sun.

So remote is their poſition, that teleſcopes which magnify 200 times, do not make a ſenſible increaſe in their appearance.

Mathematicians have endeavoured to compute their diſtance in miles; but ſo great is the extent, that numbers give but a very faint idea of the ſpace between them and us: though, indeed, we do not include them as attached to our ſyſtem, yet they are of particular ſervice to Mariners in the ſcience of Navigation, for the Longitudes of places at ſea are frequently diſcovered by the appulſe or approach of the Moon to one of theſe ſtationary guides.

Yet it would be irrationally preſumptive to conceive them ordained ſolely for our uſe, either as guides in the trackleſs ocean, or as cœleſtial lamps to illumine the earth. Philoſophy revolts at ſo narrow an idea, and admires their exiſtence for a more noble cauſe; the imparting of that vivifying ſpirit to innumerable planetary beings within their ſpheres of action, which thoſe on our Earth receive through the immediate influence of our all-glorious Sun. Here then is a range for contemplation: when our Syſtem appears but as a point in the boundleſs Univerſe, and we behold the Suns of other Syſtems, extending beyond the limits of calculation, how incomparable muſt we acknowledge the attributes of the Deity who has framed and animates ſo ſtupendous a Creation!!!

OF THE

PLANISPHERICAL PLANETARIUM.

To imprint on the youthful mind a knowledge which the foregoing pages are deſigned to impart, is the object of the *Planiſpherical Planetarium*; to offer, in delineated repreſentation, that idea which the mind ſhould conceive in order to be impreſſed with a due notion of the Earth's relative motions and ſituations. To form a juſt conception in the mind from mere peruſal, is with Youth a taſk of ſome difficulty, when the object is not of an ordinary nature; and as it too frequently occurs, that an appearance of difficulty in the outſet of ſtudy, deters the mind from penetrating beyond its ſurface, it is neceſſary to allure them to the attainment of knowledge, by familiarizing ſyſtems to their juvenile capacities; and as the eye impreſſes on the mind a more immediate and laſting knowledge than is conveyed by the ear, it is highly eſſential to conception, to give a delineated repreſentation where it can be effected, thereby making deſcription more impreſſive.

As my chief object in the *Planetarium*, is to deſcribe the motions of the Earth, and the relative ſituations it bears to the Sun, I have omitted the repreſentation of the exterior Planets, the limits of this plate being too circumſcribed to admit their inſertion, without materially diminiſhing the orbit and magnitude of the Earth: and alſo from the ſcale ſo comparatively diminutive to the repreſentation of ſuch vaſt bodies, it forbids my adherence to relative proportion in their delineation, ſince the body of our Earth would appear but as a dot, when compared even to the miniature Sun here deſcribed; and to preſerve ſuch juſt proportion, would altogether fruſtrate my deſire of repreſenting the Meridional, Parallel, and other artificial Lines, ſo indiſpenſably neceſſary in a deſcription of the terreſtrial globe.

The Centre Object in the *Planiſpherical Planetarium*, is evidently deſigned to repreſent that *principium agendi*, or ſource of action, whoſe power over, and connection with all the planetary Orbs, are particularized in the foregoing Elementary Introduction: and his various relative ſituations occaſioned by the Earth's motion, will be more clearly elucidated in treating further of that rotary Orb.

The two other interior objects, are the Planets Mercury and Venus; the former being always in the Sun's vicinity, and generally concealed from our view by the dazzing luſtre of his beams; the other is more our companion, being uſually viſible to us in a morning before ſunriſe, or in an evening after ſunſet, whence it may be properly ſaid, that ſhe

> Awhile invokes the ſongſter from his neſt;
> Awhile proclaims to herds the time of reſt.

Next comes the planet Earth, riding in its orbit round the Sun; in the repreſentation of which, as a ſubſtitute for motion, it is placed in twelve various particular poſitions, viz. thoſe wherein it is actually ſituate upon the days on which it enters into the reſpective ſigns of the Zodiac; ſhowing, in the cleareſt manner that can be effected upon a plane, its viciſſitude of poſition, and mode of revolution.

The more to aſſiſt juvenile conception, in forming a juſt idea of the rotary and revolutionary motions of our Earth, I have given a duplicate repreſentation of it, in each of its twelve particular poſitions; the interior one ſhewing the due obſervance it bears to a particular point in the heavens during the whole of its revolving courſe: which is practically exemplified by obſerving that in every period of the Earth's circumvolution, the North Pole of our Globe is invariably oppoſed to a particular point in the cœleſtial ſphere; and there being a ſtar almoſt immediately in that point, it has therefrom obtained the appellation of the North Star.

The manner of the Earth's rotation on its axis is very adequately repreſented by the Terraqueous Globe, and thereby the conſequent cauſe of day and night ſuitably exemplified; but it has been often found a difficult matter to inculcate in the mind of Youth, a proper idea of the mode of the Earth's revolution round the Sun, and, indeed, the terreſtrial or cœleſtial globes are not competent to convey readily to their minds that eſſential idea; for ſince they are particular bodies at reſt, and have the Zodiacal and Ecliptic characters marked on them, it muſt appear to the pupil, that as (deſcriptively) the Sun paſſes from one of theſe ſigns to another, that the Sun is actually the revolving body, moving round the Earth annually: but the truth is more evidently illuſtrated by this (interior) projection of the ſphere on the plane of the Ecliptic in the *Planetarium*, where it appears, that the Earth is the revolving body, and the manner in which, during its revolution, it expoſes the various parts of the Ecliptic to the Sun's centre, (thereby cauſing its variety of declination) is, I truſt, clearly demonſtrated, as alſo that it is the obliquity which the plane of the Ecliptic makes with the Poles of the Earth that occaſions the Sun to be half a year vertical in the Northern Hemiſphere, and half a year in the Southern. For its rotation is performed on the axis of the Equator, whereas it revolves on the plane of the Ecliptic, which makes an angle with either of the Poles of 66° 30′, and with the Equator of 23° 30′.

This interior delineation is more particularly deſigned to ſhow the mode of the Earth's revolution, and conſequently the cauſe of the variation of ſeaſon: but as in this projection, we have only a view of half of the terraqueous globe, in the whole twelve delineations, I have made another projection of the ſphere on a Meridional Line, by which we have a comprehenſive view of the appearance of the Earth with regard to the Sun at each of the ſame twelve periods, conveying a diſtinct idea of the ſucceſſion of day and night, occaſioned by its rotation on its axis: but there is an unavoidable defect in this delineation, which might embarraſs the young ſtudent, and therefore required the aſſiſtance of the interior projection to counteract ſuch effect, viz. that though it retains its relative poſition to the Sun during its revolutionary courſe, wherein the North Pole advances and recedes from it in regular ſucceſſion, yet it has not this retention with reſpect to a polar inclination; for in theſe twelve delineations, we ſee no two poles having the ſame inclination.—Therefore, its poſition with reſpect to the North Star is not here noticed; but this is a defect which the other projections ſupply, and theſe exterior projections furniſh a view altogether of the whole of the terreſtrial ſphere, each of them giving a North and South view of half the globe, and diſcriminate the various hours of the day and night, with the different inhabitants of the various parts of the World.

Were it poſſible to give them a polar inclination, and the ſame general repreſentation they have here, they would be perfect of themſelves; but leſt the Reader might find a deficiency for want of this tendency, I conceived it requiſite to make the interior projection with its true inclination, truſting that a duplicate repreſentation would not deduct from the intelligibility; and ſhall particularize them further, in treating of them periodically.

That circle or repreſentation of vapour which ſurrounds it in either projection, is its Atmoſphere, ſuppoſed to riſe to an elevation of about 45 miles; this menſtruum, ſo indiſpenſable both to our being and well-being, attends it during its revolution round the Sun, and adheres to it by the laws of gravitation.

The next object is the Moon, ſhewing its phaſes, or the appearance it will make to us at the various periods when the Earth enters into the reſpective ſigns: theſe phaſes are here delineated according to their appearances in the preſent year, 1797, and will conſequently have different poſitions and appearances on thoſe particular days in the years enſuing.

The exterior circle is an accurate delineation of the Zodiac with its conſtellary ſigns, and the correſpondent days anſwering to each degree of thoſe ſigns, auxiliary to thoſe which are adjoined to the Ecliptic on the Globes.

The various artificial lines or boundaries on the Globe, to determinate particular extents, have been enumerated and explained in the Introduction, and are diſtinctly and proportionably laid down upon each Globe in the *Planetarium*.

The Equator, biſecting the globe at right angles with the Poles, has the longitudinal degrees marked upon it, the Meridional Lines being 15 degrees aſunder: the parallel or Latitudinal Lines are drawn at 10 degrees apart North and South from the Equator; and the two Tropical with the Polar Circles, are placed at their reſpective diſtances, and diſtinguiſhed by dotted lines. That line or boundary which encircles the Earth, and makes an acute angle with the Equator, is the Ecliptic; it is joined to the Zodiac, to which it is in fact but an index, ſhewing the time and ſpace of terreſtrial motion; the Zodiac and Ecliptic being frequently uſed as ſynonymous terms.

Thus, after the various lines and circles on the Globe, the next thing to be conſidered is its motion; and for this purpoſe I will begin with its poſition on the day on which it enters into the firſt degree of Aquarius, being the conſtellation or ſign of the Zodiac the Sun ſeems to enter in January, the firſt month of our year.

Here we find the Earth with its ſouthern part turned towards the Sun, having Summer there; while the northern is eloigned from it, and thereby endures the chillineſs of Winter: on this day the Sun is ſaid to be in 20 degrees ſouth declination, that is, he is vertical (or directly over head) at noon, in every place lying under 20° South latitude, ſo that from his vertical poſition he cauſes there no ſhadow: though the Sun has advanced 3½ degrees of declination toward us, or more northernly, ſince his entrance laſt month, we are inſenſible of any diminution of cold, for the Earth at this period is ſo condenſed, from its little participation of the ſolar rays during the laſt two months, that this ſmall advance in declination, has no perceptible influence upon us with regard to warmth; yet a ſmall increaſe in the length of our days is diſcernible.

At his entrance into the laſt Conſtellation, the whole of the North polar circle, was involved in darkneſs, and even now there is only a very ſmall part of it expoſed to the Sun's view, ſo that they who inhabit more than 3½ degrees within the Arctic Circle, will at this period enjoy no day; but the others have the well-founded hope of ſoon enjoying the genial preſence of this Luminary, ſince he is advancing in his Northern declination, and will ſpeedily become viſible even at the Pole.

The

The Moon, at the period when the Earth is in this poſition, is in that ſtate of her orbit which is paſt oppoſition, or full, and one day previous to her arrival at her third quarter: ſhe is now advancing before the Earth in their joint revolution round the Sun.

The Earth in this (as in all its poſitions) is invariably performing a rotation on its axis every twenty-four hours, producing alternately the acceptable variation of day and night; but on account of the inclination of its axis with the plane of the Ecliptic, they differ in all parts of the world that are not in the ſame parallel of latitude: for inſtance, our days at this period are conſiderably ſhorter than our nights, whereas at the South Pole there is no night at all.

At the ſame time that the Earth is making a diurnal rotation on the axis of the Equator, it is alſo moving forward on the plane of its orbit, which, by being oblique to the poles of the Equator, produces to us the agreeable change of ſeaſons.

Having paſſed over 30 degrees of the Ecliptic, or oppoſed all the degrees of the conſtellation Aquarius to the Sun's centre, the Earth arrives at

Piſces, or the firſt degree of that ſign of the Zodiac is oppoſed to the centre of the Sun's diſk; in this progreſs the Sun has gained 9 degrees of declination towards us, or northward, ſince its entrance into the laſt ſign; but although travelling northward, it is ſtill accounted in ſouthern declination by reaſon of its being South of the Equator. The North Pole is advancing towards the Sun's face, while the ſouthern recedes from it, and at this period the increaſe of day, and the moderation of ſeaſon, are both perceptible and acceptable. The Sun being now in 11° South declination, or 9 degrees nearer than laſt month, he conſequently makes an arc over us, occaſioned by our rotation, conſiderably larger than at the period of his entrance into Aquarius, and therefore (as our rotary movement is invariably the ſame) he remains longer viſible to us now than he did at the former period, for the length of our day now is about 10¼ hours.

The interior projection, which gives a view of the Northern Hemiſphere, ſhows how gradually the North Pole is advancing into day; and the 9° of North declination which the Sun has made ſince its laſt entrance, makes even a more ſenſible difference in the North Polar Circle than it does to us in England; while the exterior projection ſhews how in the like regular progreſſion the South Pole is receding from the Sun: ſo that while the North part of the Globe is approaching to the Vernal Equinox, the South part is advancing to the Autumnal.

At this period of the Earth's revolution, the Moon, beſides having revolved once round the Earth, has gained a day, or is a day more advanced than at the laſt entrance; ſhe has arrived at the third quarter, and appears in the heavens in that ſhape which we call Half-moon, and arrives at our meridian about 6 in the morning; ſhe is now advancing with the Earth in their orbicular progreſs immediately before him, whither ſhe muſt be driven by the power of Repulſion; as in her firſt quarter ſhe retains her relative ſituations by the influence of Gravitation, being then behind the Earth.

The Earth having, in little more than 30 days, paſſed through the ſign Piſces, we view him entering into the conſtellation Aries; and the day on which it enters the firſt degree of that ſign, is called the Equinoxial Day, it being the day when the Sun's rays fall directly upon the Equator or Equinoxial Line; wherefore, as it diſtributes equal proportion of light and heat to the northward as to the ſouthward of that line, it thereby cauſes equal night and day in all parallel parts of the world, as appears by the exterior delineation: Thoſe People who live in any place directly under the Equator have, on that day, the Sun immediately vertical, or right over their heads at noon, ſo that it will cauſe there no ſhadow; hence the Sun has on this day no declination, it being calculated from this line; this is called the Vernal Equinox, becauſe it is the entrance of our Spring quarter.

That part of the Globe which is here delineated in the exterior projection, is the entire Eaſtern Hemiſphere; ſo that referring to the oppoſite, which is the Weſtern, they give together the whole ſurface of the Terreſtrial Sphere; this is the poſition of the Earth with reſpect to the Sun on the 21ſt of March at noon; now (to uſe the Geographic term) the Sun being in our Meridian, for that outward circular line which cuts off part of Europe and Africa, is our meridional line, ſuppoſed to paſs through the Obſervatory at Greenwich; we have in this delineation a view of half the illumined and of half the obſcured part of the Globe; ſo that it is day with thoſe in the enlightened part, and night with thoſe in the ſhade; as it is noon with us, ſo it is in the weſtern parts of France, Eaſt of Spain, and parts in Africa, all lying under our meridian;

whereas it is one o'clock with thoſe living under the next meridional line, on the right hand or eaſterly; two with the next; three with the next, and ſo on; each line reckoning 15° or one hour: ſo that it is midnight with thoſe under the oppoſite ſemicircular line.

It is very eaſy from this deſign to conceive the Earth's diurnal motion; for as this is its poſition at noon (and its movement is regular and perpetual), in one hour's time that ſpace of 15 degrees, next to the ſhaded ſide, will be immerſed in darkneſs, and an equal ſpace on the oppoſite part of the Globe (now concealed from us) emerged into light; and the like change every hour of its rotation, moving the ſurface of its circumference, which is 360° or 25,020 Engliſh miles, once every 24 hours.

The Moon, at this period, has gained about another day; after having completed a revolution round the Earth, ſhe is about one day paſt her third quarter verging to conjunction or new.

Moving at the rate of nearly one degree of the Ecliptic per day, the Earth paſſes through the ſign Aries, and arrives at Taurus about the 20th April, when the Sun is ſaid to be in 11 degrees

North declination; ſo it is vertical in every place lying under that parallel of latitude, as he has been in all intervening parallels between 11°. N. Lat. and the Equator, during the Earth's 30° of revolution: now again the Sun does not ſhed his influence equally over all parallel parts of the Earth, but enlightens 11° more of the Northern Hemiſphere than laſt month, and has involved 11° more of the Southern in obſcurity.

We in England, whoſe Iſle lies between the northern latitudes of 50° and 60°, begin to feel the influence of the Sun, as when he is in our meridian he is 11° nearer to our Zenith than he was laſt month, and thereby increaſes the length of our days and diminiſhes that of our nights.

In either projection of the Globe in the Planetarium, we ſee how he gradually increaſes his genial influence over the northern part of the world. The Earth was in that poſition at the Sun's entrance into the conſtellation Aries, whereby all correſpondent parts had an equal participation of his rays; but now the Earth is ſo ſituated that 11° of the North Polar Circle are brought into perpetual day (that is, without the regular ſucceſſion of night); for to thoſe who inhabit theſe regions, the Sun does not ſet, but remains viſible above the horizon for ſeveral months together; and, on the other hand, thoſe who dwell within 11° of the South Pole will be deprived of the Sun, and conſigned to the like term of night.

Our attendant, the Moon, who has made rather more than one revolution round us ſince our entrance into the laſt ſign, has advanced nearly another day in a ſecond revolution, and is again approaching to conjunction.

The Earth's ſtill continuing its twofold motion, and advancing through the ſign Taurus, arrives at the entrance of Gemini, where the Sun is found to be in 20° North declination; having only made 9° of declination by its 30° of revolution, on account of the obliquity of the Ecliptic. The Sun being now 9° more North than he was at his entrance laſt month, we conſequently feel ſtill more of his power; at this ſeaſon vegetation in ſmiles confeſſes his influence, and all nature hails the Univerſal Parent. For 9 degrees further towards the North Pole, are they now enjoying the Sun's rays, while the ſame portion is deducted from the darkening South. Our nocturnal luminary has again made more than one revolution round us, and in about four days more will be in conjunction with the Sun, and ſhow us none of her illumined part.

The Earth ſtill perſevering in its motion, and paſſing through all the degrees of the ſign Gemini, at length makes its entrance into the conſtellation Cancer; here the moſt northern part of the Ecliptic is expoſed to the Sun, who is now ſaid to be in North declination 23° 30′, having arrived at his higheſt northern aſcent, the tropic of Cancer. A meridional line which paſſes through the firſt degree of Cancer, and runs at right angles with the Poles, is called the Solſtitial Colure, and the Sun is now ſaid to be in the Summer Solſtice; and with us it is commonly called Midſummer Day.

From the laſt month's poſition of the Earth at the entrance of Gemini, the Sun has only gained 3° 30′ of declination, although it has paſſed through 30 degrees of the Ecliptic; this ſmall increaſe of declination is occaſioned by the Ecliptic's being here nearly parallel to the Tropic. The day which in March, when the Sun entered Aries, conſiſted of twelve hours (and the night of the like ſpace), is now greatly increaſed; for as the Sun makes a much larger arc over us now than he did at that period, and our rotation not being accelerated, it is evident he muſt, in performing it, remain a longer time viſible to us: the day now is 16¼ hours long, and the night conſequently

7¼ hours; ſo that we have 4¼ hours more day light than we had in March, or ſhall have in September, and (as will appear hereafter) we have 8½ hours more than we ſhall have when the Sun enters Capricornus in December.

Here the whole North Polar Circle is expoſed to the Sun's view, and although he continues to make his rotation they have no night; whereas thoſe who may inhabit the South Polar Circle, will be at this ſeaſon as inconſcious of day: but we are informed by northern navigators, that though at that Polar Circle it is day for half a year, or, in other words, though the Sun does not ſet there during its northern declination, they are frequently viſited by ſuch extreme thick fogs, as to cauſe a temporary darkneſs, and ſo furniſh them with artificial night.

But favoured Britain's mid-day Sun obſerves a happy medium between the Zenith and the Horizon, neither by his aſcendency overheating us with his powerful rays, nor by his abſence expoſing us to the chillineſs of condenſed vapours.

The Sun's altitude or height above the horizon, is now 61° 58′, whereas its altitude on the 22d of December, is only 14° 58′, which eaſily accounts for the material difference in the length of days at theſe reſpective periods. Our lunar ſatellite has, ſince our entrance into the laſt conſtellation, effected rather more than one revolution round us; ſhe is ſtill in her third quarter, but is one day nearer to conjunction than at the entrance laſt month.

The Sun (geographically) having arrived at his higheſt aſcent of northern declination, and the Earth ſtill revolving on the Ecliptic, begins to decline, or bend his apparent courſe to the Equator, in the ſame progreſſive manner in which he advanced towards the Tropic: while the Earth is paſſing through the thirty degrees of Cancer in the Ecliptic, it loſes 3½ degrees of declination, when it enters Leo; here the poſition of the Earth is, in every reſpect, the ſame as it was at the entrance into Gemini (except its being in a different part of its orbit), yet the variation of the ſeaſon is greatly contraſted; in May, when the Sun arrives at Taurus, the ſap ariſes from the roots, and vegetation prepares her Summer raiment; in the latter end of July, when the Sun enters Leo, his all-genial power is fully diſplayed in Nature's abundant foliage: although the Sun is 3½ degrees more to the ſouthward, that is, further from us than it was laſt month, yet we feel its influence more now than at that time, owing to the Sun's having ſhone ſo long upon the northern part of the world; and the day being longer than the night, the Earth becomes ſo ſaturated with heat, that the nights are too ſhort to diſpel it; and though the days now begin viſibly to decreaſe, and the nights to lengthen, yet from this ſign to the next, we generally find the hotteſt part of our Summer, occaſioned by the Earth's retention of the heat imparted by the Sun; by the ſolar beams, the condenſed vapours of the atmoſphere (which encompaſs it in Winter) are diſſipated and expelled to regions leſs heated by the Sun, as now we find the air is clear and dry, and the ſky open and delighting: 3½° of the North Polar Circle are now encompaſſed by ſhade, and the like portion of the South Polar, emerged into light.

The Moon has gained about another day upon us, and is decreaſing progreſſively in the extent of her illumined face as ſhe gradually advances in her third quarter.

The Earth having, in its revolution, expoſed the 30° of Leo to the Sun's centre, arrives at Virgo, by which progreſs we loſe 9° of declination; when in this poſition the length of our nights more ſenſibly increaſe as that of our days does perceptibly diminiſh, and the power of the Sun begins but very gradually to abate; as the North Polar Circle is receding from the Sun, ſo is the Southern Circle advancing towards it; and yet, though the Sun is travelling ſouthward, it is accounted in North declination, on account of it's being North of the Equator. Our lunar companion has reached that ſituation, where ſhe is to us in a ſtate of inviſibility; ſhe is now in conjunction, or between the Earth and Sun, conſequently as ſhe ſhines only by reflection, her enlightened part is oppoſite to the Sun, and her dark ſide toward us; when in this poſitoin we call her New Moon.

In the ſame progreſſion as the Sun advances in the Ecliptic towards the Northern Tropic, ſo he returns from that Tropic to the Equator; for the Earth, in its revolving courſe, having paſſed over the 30 degrees of Virgo, oppoſes the firſt degree of Libra to the Sun's centre: ſo that having loſt the remaining 11° of north declination, the Sun is again upon the Equator; and here we arrive at our ſecond, or Autumnal Equinox, where an equal degree of light and heat is again diſtributed to the North as to the South Pole, and to each correſponding parallel of latitude.

In the five preceding poſitions of the Earth, the Sun was in north declination, that is, he was vertical ever in ſome place North of the Equator.

The delineation in the Planetarium is the poſition of the Earth on the 21ſt of September, at midnight, (as may be ſeen in the exterior projection), ſince London lies under the moſt weſtern meridian in the ſhade; and here we have a view of the whole Weſtern Hemiſphere. In 6 hours time, by the Earth's rotation, London will move to that line which divides the light from the ſhade, on the oppoſite part of the Globe, when it will be ſix in the morning with us, and the exact time of ſunriſe; and in the like ſpace from that time, it will arrive at that ſituation which is directly oppoſite to the Sun, when it will be our noon. Although the Sun is equidiſtant from us now and at the other Equinox in March, yet we feel at this period more of the Sun's power than at the former, occaſioned by the Earth's ſtill retaining a portion of that heat which was imparted to it during the Summer.

The Moon, which perfects a revolution round us in 29½ days, gains upon us in each courſe from entrance to entrance; whereas we occupy more upon an average than 30 days: upon our entrance into this conſtellation, ſhe appears in the character of a Moon two days old; ſhe now riſes Weſt of the Sun, and conſequently after him.

By the Earth's continued progreſſive motion on the plane of the Ecliptic, the South Pole advances into the Sun's view, and the North now begins to recede from it, and the Sun gets into South declination, being now vertical in ſome part or other of the Torrid Zone, South of the Equator. The beauteous order and proportion of ſpace which the Earth obſerves in its revolution, correſpondent with the counterpart of its orbit, is pleaſing to inveſtigate.

The Sun's appearance in the Southern Hemiſphere, when it enters Scorpio, is the counterpart of its appearance to the Northern Hemiſphere, upon its entrance into Taurus; ſo that thoſe people who dwell in 51° 30′ South latitude, will have nearly the ſame kind of ſeaſon on the 22d of October that we had on the 20th of April, allowing a little for the diſproportion of ſea to land in the Southern Hemiſphere, whereby it will be more expoſed to damps and chilling air, and conſequently ſubject to a later ſeaſon. Our days are now decreaſed in proportion as they were increaſing at the former period, being of correſpondent length, and ſuffering other changes proportionate.

By the advance the Moon has made ſince we were at Cancer, ſhe has become almoſt a day older than when we viewed her at the Sun's laſt entrance, and ſhe riſes later to us every rotation.

The Sun having travelled through the ſign Scorpio, or rather the Earth having expoſed all the degrees therein to the Sun's centre (in about 30 days), and the Sun daily making a more ſouthern declination, he at length arrives at Sagittarius, when we feel the abſence of the Sun more perceptibly, by the deficiency of that light he was wont to impart, and the contraction of his arc above our Horizon, whereby he makes a ſhorter diurnal paſſage, and conſequently cauſes a diminution in the emiſſion of his heat; but then all-provident Nature diſtributes to our Antæci and Antipodes thoſe bleſſings which ſhe temporarily abducts from us; and thus we alternately participate the welcome variation of ſucceſſive ſeaſons. The South Polar Circle has gained 9° more of the Sun's light than it poſſeſſed at Libra, and enjoys the ſame advantages which the North Pole did at Gemini.

The Moon, during this part of the Earth's revolution, has gained her proportion of time, and has made a conſiderable advance in her firſt quarter; on the day of the Sun's arrival at this ſign of the Zodiac, ſhe is in her aſcending node, and is advancing towards oppoſition.

Onward

The Earth ſtill perſevering in its perpetual motion, arrives by its revolving progreſſion at the entrance of Capricornus; this is on the beginning of the 22d day of December, when the North Pole is at its extreme diſtance from the Sun, and the whole Polar Circle is deprived of his enlivening view, which cauſes invariable night in the Northern Polar Regions, and thereby ſo increaſes the intenſity of cold, that they remain unviſited by Europeans during theſe obſcure months.

The Sun having arrived at 23° 30′, which is the extent of his ſouthern declination, the whole of the South Polar Circle becomes expoſed to his face, and poſſeſſes a proportionate length of day to the night, endured within the Northern Circle.

The Sun here arrives at the Tropic of Capricornus, which is its confine or boundary in the South Torrid Zone: the day on which it arrives here is our ſhorteſt in the year, conſiſting of but 7¼ hours; and the night conſequently the longeſt, containing 16¾ hours, compoſing together the 24.

As the Sun at noon is diſtant from our zenith 23° more than when we entered Libra, ſo the arc he makes by our rotation is conſiderably leſs than at that time; whereby he is ſo ſhort a time expoſed to our view, and the reflection of his rays ſo conſiderably more oblique, that the heat which he emits is leſs now, upon our part of the globe, than at any other period of the year.

The Moon, at the period of this poſition of the Earth, is within two days of that part of her orbit, wherein we ſee but half of her illumined ſide, and whence ſhe is called Half-moon.

Thus cloſes the view of the Annual and Diurnal Motions of our reſtleſs Earth, whoſe extenſive ſurface moves annually over a ſpace of above Five Hundred Millions of Miles; an amount, which ſurprizes the imagination, and fills the contemplative mind with pious admiration of the Divine Artificer, whoſe Omnipotency is ſo manifeſtly pourtrayed in the immaculate ſtructure of the ſtupendous Univerſe!

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CHARACTERISTIC
MARKS AND TERMS
MADE USE OF IN
Aſtronomy, Geography, and Navigation.

TWELVE SIGNS OF THE ZODIAC.

♈	♉	♊	♋
Aries,	*Taurus,*	*Gemini,*	*Cancer,*
♌	♍	♎	♏
Leo,	*Virgo,*	*Libra,*	*Scorpio,*
♐	♑	♒	♓
Sagittarius,	*Capricornus,*	*Aquarius,*	*Piſces.*

PLANETARY CHARACTERS.

☉	☿	♀	⊖	☽	♂
Sun,	*Mercury,*	*Venus,*	*Earth,*	*Moon,*	*Mars,*

♃	♄	♅
Jupiter,	*Saturn,*	*Georgium Sidus.*

CHARACTERS REPRESENTING THE DAYS OF THE WEEK.

Sun,	*Moon,*	*Mars,*	*Mercury,*
☉	☽	♂	☿
Sunday,	*Monday,*	*Tueſday,*	*Wedneſday,*
or	*or*	*or*	*or*
Dies Solis.	*Dies Lunæ.*	*Dies Martis.*	*Dies Mercurii.*

Jupiter,	*Venus,*	*Saturn,*
♃	♀	♄
Thurſday,	*Friday,*	*Saturday,*
or	*or*	*or*
Dies Jovis.	*Dies Veneris.*	*Dies Saturni.*

CHARACTERS OF ABBREVIATION.

—.	.—
Eaſt Longitude.	*Weſt Longitude.*
¡	!
North Latitude.	*South Latitude.*

CHARACTERISTICS OF TIME AND SPACE.

°	′	″	‴	⁗
Degrees,	*Minutes or Miles,*	*Seconds,*	*Thirds,*	*Fourths.*

A. M. Anti Meridian—before the Sun arrives at our Meridian, or Noon.

P. M. Poſt Meridian—after the Sun has paſſed the Meridian, or After-noon.

FINIS.

CHARACTERISTICS OF TIME AND SPACE.

° ′ ″ ‴

Degrees, *Minutes or Miles*, *Seconds*, *Thirds*,

⁗

Fourths.

A.M. *ante Meridiem*—before the Sun arrives at our Meridian, or Noon.

P.M. *Post Meridiem*—after the Sun has passed the Meridian, or After-noon.

NEW INVENTED COMPASSES,

Particularly eſſential to thoſe who ſtudy or practice
GEOMETRY.

Theſe Compaſſes, by a ſimple Contrivance, ſhow, per Means of a Dial, at every Extenſion of their Legs, the exact angular Diſtance of their Points; and at the ſame Time the Diameter of a Circle (in Inches) which the Legs ſo extended will deſcribe: thereby ſaving the Geometrician much Trouble in producing theſe Requiſites without the Neceſſity of Meaſurement.

ALSO THE

COMPASS DIALS;

A Graduated Circle, by which the Bearings of Places from one another, on Charts, are aſcertained with Preciſion.

INVENTED, MANUFACTURED, AND SOLD,
By T. HARRIS,
OPTICIAN,
No. 30, *Hyde Street, Bloomſbury.*